PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference PE18807PC00	**FOR FURTHER ACTION** See Form PCT/IPEA/416	
International application No. PCT/EP2004/053191	International filing date *(day/month/year)* 01.12.2004	Priority date *(day/month/year)* 23.12.2003
International Patent Classification (IPC) or national classification and IPC INV. H04L12/56 H04L12/28		
Applicant TELEFONAKTIEBOLAGET LM ERICSSON (PUBL) et al.		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 5 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in celectronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

☒	Box No. I	Basis of the report
☐	Box No. II	Priority
☐	Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
☐	Box No. IV	Lack of unity of invention
☒	Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
☐	Box No. VI	Certain documents cited
☐	Box No. VII	Certain defects in the international application
☐	Box No. VIII	Certain observations on the international application

Date of submission of the demand	Date of completion of this report
07.07.2005	28.03.2006
Name and mailing address of the international preliminary examining authority: European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized officer Tous Fajardo, J Telephone No. +49 30 25901-489

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/EP2004/053191

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-23	as originally filed

Claims, Numbers

1-19	received on 07.07.2005 with letter of 16.06.2005

Drawings, Sheets

1/8-8/8	as originally filed

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	6-11,18
	No:	Claims	1-5,12-17,19
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-19
Industrial applicability (IA)	Yes:	Claims	1-19
	No:	Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

Reference is made to the following documents:

D1: BISWAS S ET AL: "Opportunistic Routing in Multi-Hop Wireless Networks" SECOND WORKSHOP ON HOT TOPICS IN NETWORKS, [Online] 20 November 2003 (2003-11-20), pages 1-6, XP002319888 CAMBRIDGE, USA Retrieved from the Internet: URL:http://www.acm.org/sigs/sigcomm/HotNet s-II/papers/opportunistic_routing.pdf> [retrieved on 2005-03-02]

D2: NGUYEN T ET AL: "Path Diversity with Forward Error Correction(PDF) System for Packet Switched Networks" INFOCOM 2003. TWENTY-SECOND ANNUAL JOINT CONFERENCE OF THE IEEE COMPUTER AND COMMUNICATIONS SOCIETIES, vol. 1, 30 March 2003 (2003-03-30), pages 663-672, XP002319889

1) The application does not meet the requirements of Article 6 PCT, because claims 1, 13, 14 and 19 are not clear.

1.1) The expressions "determining a plurality of simultaneously potential next hop nodes for at least one of multiple nodes" and "said (simultaneously potential) nodes jointly optimize" in said claims are ambiguous and could be interpreted in many different ways.

As said plurality of simultaneously potential next hop nodes form a subset of the neighboring nodes to said at least one of multiples nodes, they could refer to the set of all nodes which could be potential very first next hop nodes in a path joining said at least one of multiples nodes and a destination node, so that they all are seen **simultaneously** as **potential** very first next hop nodes in said path.

i) This set of nodes could be formed by all the potential very first next hop nodes taken individually. They all are considered to find the next hop node which results in an optimized cost function, so that they **jointly optimize** the cost function.

ii) This set of nodes could also be formed by a number of sets (i.e., said set is a set of sets). Some of these sets could include more than one potential very first next hop node, in which case a kind of opportunistic routing algorithm could be used: the potential next hop nodes in such a set could **jointly optimize** the cost function.

1.2) Furthermore, claims 1, 13, 14 and 19 attempt to define the subject-matter in terms of the result to be achieved ("jointly optimize a predetermined cost function"), which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.

2) Furthermore, the above-mentioned lack of clarity notwithstanding, the subject-matter of **claims 1, 13, 14 and 19** is not new in the sense of Article 33(2) PCT, and therefore the criteria of Article 33(1) PCT are not met.

2.1) Document D1 (see paragraph 3.1) discloses the subject-matter of claims 1, 13, 14 and 19 if they are interpreted as in paragraph 1.1-ii above.

2.2) Document D2 (see page 667, left-hand column, line 55 - right-hand column, line 25) discloses the subject-matter of claims 1, 13, 14 and 19 if they are interpreted as in paragraphs 1.1-i above.

3) Dependent **claims 1-12 and 15-18** do not contain any features which, in combination with the features of any claim to which they refer, meet the requirements of the PCT in respect of novelty and/or inventive step, see documents D1 and D2 and the corresponding passages cited in the search report.

CLAIMS

1. A method for cost determination in a multihop communications network, **characterized by** the steps of:

determining a plurality of simultaneously potential next hop nodes for at least one of multiple nodes from a source node to a destination node in the network, such that said simultaneously potential nodes jointly optimize a predetermined cost function, said plurality of simultaneously potential next hop nodes form a subset of the neighboring nodes to said at least one of multiple nodes; and

determining the optimal cost for said at least one of multiple nodes to be equal to the optimized value of the predetermined cost function.

2. The method according to claim 1, **characterized by** optimizing said predetermined cost function based at least partly on an individual cost for each possible next hop node for said at least one multiple nodes.

3. The method according to claim 1 or 2, **characterized by** optimizing said predetermined cost function based at least partly on a cost factor due to said at least one of multiple nodes.

4. The method according to any of claims 1-3, **characterized by** determining a plurality of simultaneously potential next hop nodes and an associated optimal cost node by node, until a mesh of simultaneously potential routes is provided from the source node to the destination node.

5. The method according to any of claims 1-4, **characterized by** determining link parameters that together with the plurality of simultaneously potential next hop nodes jointly optimizes a predetermined cost function.

6. The method according to claim 1, **characterized by** determining the plurality of simultaneously potential next hop nodes for a node i based on optimization of a predetermined cost function f_1 according to:

$$\underset{S_j'' \in S''}{Optimize}\ f_1\left(Cost_{S_{j(k)}''}, \Delta Cost_{i,S_{j(k)}''} \middle| \forall S_{j(k)}'' \in S_j''\right) \Rightarrow Cost_i(opt), S_j''(opt)$$

where S'' represents all possible next hop nodes for node i, S_j'' represents all possible combinations of the nodes in S'', $Cost_{S_{j(k)}''}$ is the individual cost of node $S_{j(k)}''$ in one particular set S_j'', and $\Delta Cost_{i,S_{j(k)}''}$ is the cost of going from node i to node $S_{j(k)}''$, and $Cost_i\ (opt)$ is the optimum cost for node i and $S_j''(opt)$ is the set of simultaneously potential next hop nodes.

7. The method according to claim 6, **characterized by** determining the plurality of simultaneously potential next hop nodes for node i based on optimization of a predetermined cost function according to:

$$\underset{S_j'' \in S''}{Optimize}\left(f_1\left(Cost_{S_{j(k)}''}, \Delta Cost_{i,S_{j(k)}''} \middle| \forall S_{j(k)}'' \in S_j''\right)\right) \circ Const_i \Rightarrow Cost_i, S_j''(opt),$$

where $\circ$ is an arbitrary arithmetic operation depending on choice and design goal, and $Const_i$ is a term which node i may include in the cost.

8. The method according to claim 7, **characterized by** determining the plurality of simultaneously potential next hop nodes for a node i based on optimization of a predetermined cost function according to:

$$Cost_i = \underset{S_j'' \in S''}{Optimize}\left\{ \underset{Par}{Optimize}\left\{ Cost_{i,S_j''}(Par) \circ f_2\left(Cost_{S_{j(k)}''} \middle| \forall S_{j(k)}'' \in S_j''\right)\right\}\right\} \circ Const_i$$

$$\Rightarrow Cost_i(opt), S_j''(opt), Par(opt)$$

where *Par* is an n-dimensional link parameter space, where $n=1, 2, \ldots, Cost_{i,S_j''}(Par)$ represents the cost to send data from node i to a node in the set S_j'' as a function of the link parameter space *Par* and the set of nodes S_j'', and *Par(opt)* is the optimum set of link parameters for forwarding data.

9. The method according to claim 7 or 8, **characterized by** selecting the term $Const_i$ depending on topology connectivity and/or dynamic properties of the network.

10. The method according to any of claims 7-9, **characterized by** selecting the term $Const_i$ depending on stochastic variables.

11. The method according to any of claims 7-10, **characterized by** selecting the term $Const_i$ depending on at least one of interference, battery status at node *i* and a queuing situation at said node *i*.

12. The method according to any of claims 1-11, **characterized by** associating the cost for a node with at least one of delay, interference, number of hops and path loss.

13. A method for cost optimization in a routing protocol in a communications network, **characterized by** optimizing a predetermined cost function, whereby an optimal cost and a plurality of simultaneously potential next hop nodes are determined for at least one of multiple nodes from a source node to a destination node, said plurality of simultaneously potential next hop nodes form a subset of the neighboring nodes to said at least one of multiple nodes.

14. A system for cost determination in a multihop communications network, **characterized by**:

means for determining a plurality of simultaneously potential next hop nodes for at least one of multiple nodes from a source node to a destination node in the network such that said nodes jointly optimize a predetermined cost function, said plurality of simultaneously potential next hop nodes form a subset of the neighboring nodes to said at least one of multiple nodes; and

means for determining an optimal cost, for said at least one of multiple nodes, to be equal to the optimized value of the predetermined cost function.

15. The system according to claim 14, **characterized by** said determining means being adapted to optimize said predetermined cost function based at least partly on an individual cost for each possible next hop node for said at least one of multiple nodes..

16. The system according to claim 14-15, **characterized by** means adapted to determine a plurality of simultaneously potential next hop nodes an associated optimal cost node by node, until a mesh of simultaneously potential routes is provided from the source node to the destination node.

17. The system according to any of claims 14-16, **characterized by** means adapted to determine link parameters that together with the plurality of simultaneously potential next hop nodes jointly optimize a predetermined cost function.

18. The system according to claim 14-17, **characterized by** said determining means being adapted to optimize a predetermined cost function f_1 according to:

$$\underset{S''_j \in S''}{Optimize}\ f_1\left(Cost_{S''_{j(k)}}, \Delta Cost_{i,S''_{j(k)}} \middle| \forall S''_{j(k)} \in S''_j\right) \Rightarrow Cost_i(opt), S''_j(opt)$$

where S'' represents all possible next hop nodes for node i, S_j'' represents all possible combinations of the nodes in S'', $Cost_{S_j''(k)}$ is the individual cost of node $S_{j(k)}''$ in one particular set S_j'', and $\Delta Cost_{i,S_j''(k)}$ is the cost of going from node i to node $S_{j(k)}''$, and $Cost_i\ (opt)$ is the optimum cost for node i and $S_j''(opt)$ is the set of simultaneously potential next hop nodes.

19. A node in a multihop communications network, **characterized by**

means for determining a plurality of simultaneously potential next hop nodes for said node, such that said simultaneously potential next hop nodes jointly optimize a predetermined cost function, said plurality of simultaneously potential next hop nodes form a subset of the neighboring nodes to said at least one of multiple nodes; and

means for determining an optimal cost for the node to be equal to the optimized value of the predetermined cost function.,

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